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Preference for and Acceptability of Two Formulations of a Dietary Supplement Containing Calcium Plus Vitamin D_3: A Randomized, Open-Label, Crossover Trial in Adult Patients with Calcium and Vitamin D Deficiencies*

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ABSTRACT

Background: Preference for and acceptability of a drug are crucial for compliance and hence optimal treatment of diseases that require long-term management (eg, osteoporosis). The preference for and acceptability of a chewable tablet containing calcium and vitamin D_3 and a dose-comparable effervescent powder were assessed in a Phase 4, randomized, open-label, crossover trial in 5 European countries (Sweden, Finland, Belgium, the Netherlands, and Greece).

Objective: The aim of the present analysis was to compare the preference for and acceptability, including tolerability, of these 2 formulations based on the Belgian results of the previously mentioned study.

Methods: Patients were recruited from 3 osteoporosis units and university hospitals in Brussels, Liege, and Ghent, Belgium. Adult patients at risk for calcium and vitamin D deficiencies were enrolled. The study drugs included 2 formulations of a dietary supplement containing a combination of calcium plus vitamin D_3: chewable tablets (calcium carbonate, 1250 mg; vitamin D_3, 400 IU) (A) and effervescent powder (calcium carbonate, 1250 mg; vitamin D_3, 440 IU) (B). Patients were randomly assigned to receive 1 of 2 treatment sequences: AB or BA. Both formulations were given PO BID for 14 days, with a switch to the alternate formulation occurring on day 15 of the study. Preference and acceptability were assessed using 2 questionnaires: one assessed 5 variables of acceptability using 11-point scales, and the other assessed preference using yes/no questions. Compliance and tolerability were recorded throughout the study, with unused dose counts and recording of adverse events (AEs), respectively.

Results: The study comprised 200 patients, 199 of whom received at least 1 dose of study medication and were included in the intent-to-treat analysis (174 women, 25 men; mean age, 66 years [range, 30–87 years]). Preference data were

*Trial investigators are listed in the Acknowledgments.

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available in 178 patients, 129 of whom (72.5%) preferred the chewable tablet compared with 34 (19.1%) who preferred the effervescent powder and 15 (8.4%) who had no preference (both, $P < 0.001$ vs tablet). The preference for the tablet was based on consistently and significantly higher mean scores on all 5 variables of acceptability (all, $P < 0.001$). The most common AEs were gastrointestinal (tablet, 27/192 patients [14.1%]; powder, 31/190 patients [16.3%]). Eighteen patients (9.0%) discontinued the trial due to ≥1 AE (12 receiving the tablet and 6 receiving the powder).

Conclusions: In this study of preference for and acceptability of 2 formulations (chewable tablet and effervescent powder) of a dietary supplement containing a combination of calcium plus vitamin D_3 in Belgian adults at risk for calcium and vitamin D deficiencies, the chewable tablet was preferred by a significant majority. Based on 5 variables, the tablet was found to be significantly more acceptable than the powder. Tolerability was similar between the 2 formulations. (*Curr Ther Res Clin Exp.* 2005;66:23–34) Copyright © 2005 Excerpta Medica, Inc.

Key words: acceptance, calcium, elderly, formulation, osteoporosis, preference, vitamin D_3.

INTRODUCTION

The aim of pharmacotherapy in primary and secondary osteoporosis is to prevent bone fractures. Dietary supplements containing calcium and/or vitamin D_3, sometimes in combination with bisphosphonates, hormone replacement therapy, or calcitonin, are widely used for the prevention and treatment of calcium deficiency, vitamin D_3 deficiency, and/or osteoporosis. A stand-alone regimen of a supplement containing calcium plus vitamin D_3 decreases bone mineral density (BMD) loss and thus the risk for fractures. This treatment also prevents hypocalcemic reactions to inhibitors of bone resorption, which in turn stimulates parathyroid hormone secretion.

With the drugs currently available for the treatment of osteoporosis, long-term (possibly lifelong) dosing is needed for treatment success.[1–4] However, pharmacotherapy may be complicated by adverse events (AEs) or inconvenient dosing, leading to poor treatment compliance.[5,6] It has also been suggested that compliance with long-term oral therapy is related to the taste, size, and formulation of the drug.[7–9] For example, pleasant taste and oral sensation are important for compliance with chewable tablets.[7–9]

The preference for and acceptability of a chewable tablet containing calcium and vitamin D_3 and a dose-comparable effervescent powder were assessed in a Phase 4, randomized, open-label, crossover trial in 5 European countries (Sweden, Finland, Belgium, the Netherlands, and Greece).[10] The aim of the present analysis was to compare the preference for and acceptability, including tolerability, of these 2 formulations based on the Belgian results of that study.

PATIENTS AND METHODS

Study Design

The protocol of the European study complied with the current version of the Declaration of Helsinki and its amendments and the good clinical practice guidelines. In Belgium, the ethics committees at each of the 3 study sites and the Agency of Medicines, Brussels, Belgium, approved the protocol of the trial, which was conducted between July 2002 and September 2003.

Inclusion and Exclusion Criteria

Patients aged ≥18 years at risk for calcium and vitamin D deficiencies, determined using physician assessment and the indications in the package inserts of the 2 trial medications,[11,12] were recruited from 3 osteoporosis units and university hospitals in Brussels, Liege, and Ghent, Belgium.

Patients were excluded if they had received either study medication within 6 months before the study, had any condition for which the trial drugs were contraindicated (eg, hypercalcemia, hypercalciuria, Zollinger-Ellison syndrome, nephrolithiasis), or were to undergo surgery during the 28-day study period.

Pregnant, possibly pregnant, or breastfeeding women were excluded from the study. Women of childbearing age were required to use an effective method of birth control throughout the study.

Participation in the study was voluntary and unpaid. However, patients were offered compensation for transportation to and from the study sites.

Study Drug Administration

The trial drugs included 2 formulations of a dietary supplement containing a combination of calcium plus vitamin D_3: chewable tablets* (calcium carbonate, 1250 mg; vitamin D_3, 400 IU) (A) and effervescent powder† (calcium carbonate, 1250 mg; vitamin D_3, 440 IU) to be dissolved in 150 mL of water (B). Using a computer-generated list of random numbers, patients were randomly assigned to receive 1 of 2 treatment sequences: AB or BA. Both formulations were given PO BID (morning and evening) for 14 days, which was considered an adequate duration for a patient to become sufficiently familiar with the formulation to assess preference and acceptability. Both formulations were distributed to patients in the original packaging (60 tablets or 30 sachets of powder). Patients receiving drugs known to interact with the trial drugs (eg, digoxin, tetracycline, fluoroquinolones, bisphosphonates, iron, sodium fluoride, diuretics, phenytoin, barbiturates, corticosteroids, levothyroxine, ion exchange resins, laxatives) were instructed not to take the supplement at the same time as the medication in question (eg, to take the supplement 3 hours before or after bisphosphonate dosing).

*Trademark: Steovit D_3® (Nycomed Christiaens SCA, Brussels, Belgium).
†Trademark: Calcit D_3® (Procter & Gamble, Strombeek-Bever, Belgium).

Visit Procedures

At visit 1 (day 1; baseline), patients provided written informed consent to participate; conformity with eligibility criteria was assessed; and baseline demographic and clinical characteristics (including smoking and drinking habits; disease history [including osteopenia, osteoporosis, and fractures], and concomitant drug use) were recorded. Patients were randomized to a treatment sequence, provided with the appropriate supplement, and asked to return in 14 days.

At visit 2 (day 15), patients returned any unused doses, which were counted for compliance assessment. Patients completed a 5-variable acceptability questionnaire, which used the following widely accepted but not validated 11-point rating scales: taking the dose out of the container (scale: 0 = very difficult to 10 = very easy), taking the dose (scale: 0 = very difficult to 10 = very easy), taste (scale: 0 = very bad to 10 = very good), time spent taking the dose (scale: 0 = very troublesome to 10 = no problem at all), and general convenience of taking the dose (scale: 0 = very difficult to 10 = very easy). All AEs (defined as events that occurred after informed consent was provided or worsened if present at baseline and identified using patient interview) that occurred between visits 1 and 2 (period 1) were recorded. Patients received the alternate formulation and were again asked to return in 14 days.

At visit 3 (day 29), unused doses were counted for compliance assessment. Patients completed the acceptability questionnaire and a preference questionnaire, which assessed preference for a formulation (primary end point). AEs that occurred between visits 2 and 3 (period 2) were recorded.

Statistical Analysis

Sample size was determined based on the primary end point and a previous trial with a similar design by Rees and Howe.[8] The null hypothesis was that the preference for either trial drug would be 50%, and the alternative hypothesis was that the preference for either trial drug would be 60%. According to binomial theory, inclusion of 200 participants would result in a power of 78% in the country-specific statistical analysis.

$P < 0.05$ was used to identify statistical significance. Statistical analyses were performed for the intent-to-treat (ITT) population, defined as all patients who received at least 1 dose of the trial drug. The primary end point was analyzed using a logistic regression model equivalent to the Fisher exact test, as described in the article by Gart.[13] Preference for a formulation was the dependent variable in the logistic regression model; sequence of treatment was the independent variable. The intercept in the model provided an estimate of the difference between the 2 formulations, and treatment sequence was an estimate of the sequence effect. The secondary efficacy end points (taking the dose out of the container, taking the dose, taste, time spent taking the dose, and general convenience of taking the dose) were analyzed using a linear mixed model, with treatment and period as fixed effects and number of patients as the random

effect. SAS version 8.2 (SAS Institute Inc., Cary, North Carolina) was used in all statistical analyses.

RESULTS

Patient Population

The Belgian study comprised 200 patients, 199 of whom received at least 1 dose of trial drug and thus were included in the ITT analysis (174 women, 25 men; mean age, 66 years [range, 30–87 years]). Although 100 patients were assigned to each treatment sequence, some patients were inadvertently given the incorrect sequence (number of patients receiving sequence AB, 104; BA, 95). One patient did not return for follow-up and so was withdrawn from the analysis.

One hundred twelve patients (56.3%) were aged >65 years. Sixteen patients (8.0%) indicated that they smoked >10 cigars or cigarettes daily, and 27 (13.6%) indicated that they drank alcohol daily. There was a history of osteopenia in 29 patients (14.6%), osteoporosis in 101 (50.8%), and fracture in 53 (26.6%). Comorbid disease was reported in all 199 patients (100.0%), and concomitant drug use in 192 (96.5%). One hundred seventy-two patients (86.4%) completed the study.

Preference

Preference data were available in 178 patients. Seventy-two of 91 patients (79.1%) receiving sequence AB and 57 of 87 (65.5%) receiving sequence BA preferred the tablet (both, $P < 0.001$) (**Table I**). Overall, 129 patients (72.5%) preferred the tablet compared with 34 (19.1%) who preferred the powder and 15 (8.4%) who had no preference (both, $P < 0.001$ vs tablet). Except for sex (more men [21 of 24 (87.5%)] than women [108 of 154 (70.1%)] preferred the tablet); demographic and clinical characteristics (eg, age; smoking and drinking habits; history of osteoporosis, osteopenia, and fracture) were not found to be significantly associated with preference (**Table II**). Seventy-four of 101 patients (73.3%) aged >65 years preferred the tablet.

Table I. Comparison of preferences between 2 oral formulations of a dietary supplement containing calcium and vitamin D_3 in Belgian adults (no. [%]) at risk for calcium and vitamin D deficiencies.

	Preference		
Treatment Sequence	Chewable Tablet	Effervescent Powder	None
AB (n = 91)	72 (79.1)	10 (11.0)*	9 (9.9)
BA (n = 87)	57 (65.5)	24 (27.6)*	6 (6.9)
Total (N = 178)	129 (72.5)	34 (19.1)*	15 (8.4)*

A = chewable tablet; B = effervescent powder.
*$P < 0.001$ versus chewable tablet.

Table II. Preference results, distributed by demographic and clinical characteristics, for 2 formulations of a dietary supplement containing a combination of calcium and vitamin D_3 in Belgian adults (no. [%]) at risk for calcium and vitamin D deficiencies.*

Variable	All Patients (N = 178)	Preference		
		Chewable Tablet (n = 129)	Effervescent Powder (n = 34)	None (n = 15)
Demographic characteristic				
Sex				
Female	154 (86.5)	108 (70.1)	33 (21.4)	13 (8.4)
Male	24 (13.5)	21 (87.5)	1 (4.2)	2 (8.3)
Age group, y				
≤65	77 (43.3)	55 (71.4)	16 (20.8)	6 (7.8)
>65	101 (56.7)	74 (73.3)	18 (17.8)	9 (8.9)
Clinical characteristic				
Smoke >10 U/d†				
Yes	14 (7.9)	11 (78.6)	3 (21.4)	0 (0.0)
No	164 (92.1)	118 (72.0)	31 (18.9)	15 (9.1)
Drink alcohol daily				
Yes	26 (14.6)	22 (84.6)	3 (11.5)	1 (3.8)
No	152 (85.4)	107 (70.4)	31 (20.4)	14 (9.2)
Disease history				
Osteoporosis				
Yes	95 (53.4)	69 (72.6)	17 (17.9)	9 (9.5)
No	83 (46.6)	60 (72.3)	17 (20.5)	6 (7.2)
Osteopenia				
Yes	26 (14.6)	18 (69.2)	6 (23.1)	2 (7.7)
No	152 (85.4)	111 (73.0)	28 (18.4)	13 (8.6)
Fracture				
Yes	48 (27.0)	34 (70.8)	10 (20.8)	4 (8.3)
No	130 (73.0)	95 (73.1)	24 (18.5)	11 (8.5)

*Percentages may not total 100 due to rounding.
†1 U = 1 cigar or cigarette.

Acceptability

The mean scores of all 5 acceptability variables were consistently and significantly higher for the tablet than for the powder (all, $P < 0.001$) (**Table III**). The 2 variables for which the scores were most different between the 2 formulations were time spent taking the dose (85.2% for the tablet vs 52.5% for the powder; $P < 0.001$) and general convenience of taking the dose (83.6% for the tablet vs 51.4% for the powder; $P < 0.001$).

Table III. Percentages of patients who rated oral formulations as 9 or 10 on the acceptability questionnaire.*†

Scale	Chewable Tablet	Effervescent Powder
Taking the dose	86.2	59.6
Time spent taking the dose	85.2	52.5
Taking the dose out of the container	84.0	56.6
General convenience of taking the dose	83.6	51.4
Taste	68.8	56.3

*The 5-variable acceptability questionnaire used the following widely accepted but not validated 11-point rating scales: taking the dose out of the container (scale: 0 = very difficult to 10 = very easy), taking the dose (scale: 0 = very difficult to 10 = very easy), taste (scale: 0 = very bad to 10 = very good), time spent taking the dose (scale: 0 = very troublesome to 10 = no problem at all), and general convenience of taking the dose (scale: 0 = very difficult to 10 = very easy).
†$P < 0.001$ between formulas for all 5 variables of acceptability.

Compliance and Tolerability

The compliance analysis included 189 patients. The mean (median) numbers of trial doses used were 27.0 (27.0) for the tablet and 24.6 (27.0) for the powder. The mean (median) durations of intake were 13.5 (14.0) days for the tablet and 12.9 (13.0) days for the powder.

The tolerability analysis of the tablet formulation included 192 patients; the powder formulation, 190 patients. Although statistical analysis was not performed on the tolerability results, the total number of, most frequent, severity of, and causality of AEs were similar between the 2 formulations. The most common AEs were gastrointestinal (tablet, 27 patients [14.1%]; powder, 31 patients [16.3%]). The most frequently reported AEs were constipation (tablet, 11 patients [5.7%]; powder, 6 [3.2%]), dyspepsia (tablet, 4 [2.1%]; powder, 6 [3.2%]), and stomach discomfort (tablet, 4 [2.1%]; powder, 4 [2.1%]) (**Table IV**). Of the 79 AEs considered probably or possibly related to trial medication, 38 occurred in 29 patients (15.1%) during treatment with the tablet, and 41 events occurred in 33 patients (17.4%) during treatment with the powder. Seven severe AEs were reported: tablet, 6 AEs (1 patient [0.5%] each, exacerbated pain, *Escherichia pneumonia* infection, back pain, arthralgia, multiple myeloma, and exacerbated chronic obstructive pulmonary disease); powder, 1 AE (back pain [1 patient (0.5%)]). Eighteen patients (9.0%) discontinued the trial due to ≥1 AE (**Tables IV** and **V**). The most common AEs leading to discontinuation were aggravated constipation (tablet, 3 patients (1.6%); powder, 3 [1.6%]), dyspepsia (tablet, 4 [2.1%]; powder, 2 [1.1%]), and diarrhea not otherwise specified (tablet, 0 [0.0%]; powder, 2 [1.1%]). All participants who discontinued due to an AE recovered completely.

Table IV. Prevalence of possibly/probably treatment-related adverse events (AEs) with 2 oral formulations of a dietary supplement containing a combination of calcium plus vitamin D_3 in Belgian adults at risk for calcium and vitamin D deficiencies.*

	Chewable Tablet (n = 192)†		Effervescent Powder (n = 190)‡	
System/AE	No. (%) of Patients	No. of AEs	No. (%) of Patients	No. of AEs
Gastrointestinal				
Constipation	11 (5.7)	11	6 (3.2)	6
Dyspepsia	4 (2.1)	4	6 (3.2)	6
Stomach discomfort	4 (2.1)	4	4 (2.1)	4
Constipation, aggravated	3 (1.6)	3	3 (1.6)	3
Nausea	2 (1.0)	2	6 (3.2)	6
Diarrhea NOS	2 (1.0)	2	4 (2.1)	4
Vomiting NOS	1 (0.5)	1	2 (1.1)	2
Bleeding hemorrhoids	1 (0.5)	1	0 (0.0)	0
Dry mouth	1 (0.5)	1	0 (0.0)	0
Esophagitis, aggravated	1 (0.5)	1	0 (0.0)	0
Stomatitis	1 (0.5)	1	0 (0.0)	0
Abdominal distension	0 (0.0)	0	1 (0.5)	1
Dyspepsia, aggravated	0 (0.0)	0	1 (0.5)	1
Esophagitis NOS	0 (0.0)	0	1 (0.5)	1
Flatulence	0 (0.0)	0	1 (0.5)	1
Gastrointestinal upset	0 (0.0)	0	1 (0.5)	1
Retching	0 (0.0)	0	1 (0.5)	1
All	27 (14.1)	30	31 (16.3)	37
General disease/ administration site				
Condition aggravated	1 (0.5)	1	1 (0.5)	1
Pain NOS	1 (0.5)	1	0 (0.0)	0
All	2 (1.0)	2	1 (0.5)	1
Metabolic and nutritional				
Eating disorders	1 (0.5)	1	1 (0.5)	1
All	1 (0.5)	1	1 (0.5)	1
Musculoskeletal and connective tissue				
Back pain	1 (0.5)	1	0 (0.0)	0
All	1 (0.5)	1	0 (0.0)	0
Respiratory, thoracic, and mediastinal				
Dry throat	1 (0.5)	1	0 (0.0)	0
Pharyngitis	0 (0.0)	0	1 (0.5)	1
All	1 (0.5)	1	1 (0.5)	1

(continued)

Table IV. (Continued)

System/AE	Chewable Tablet (n = 192)† No. (%) of Patients	Chewable Tablet (n = 192)† No. of AEs	Effervescent Powder (n = 190)‡ No. (%) of Patients	Effervescent Powder (n = 190)‡ No. of AEs
Skin and subcutaneous tissues				
Eczema	2 (1.0)	2	0 (0.0)	0
Rash NOS	1 (0.5)	1	0 (0.0)	0
Pruritus	0 (0.0)	0	1 (0.5)	1
All	3 (1.6)	2	1 (0.5)	1
Total	29 (15.1)	38	33 (17.4)	41

NOS = not otherwise specified.
*Statistical analysis of tolerability was not performed.
†Twelve patients (6.3%) receiving the chewable tablet discontinued the study due to AEs, including dyspepsia (4 patients [2.1%]), and aggravated constipation (2 patients [1.0%]).
‡Six patients receiving the effervescent powder discontinued the study due to AEs, including aggravated constipation (3 patients [1.6%]), and diarrhea NOS and dyspepsia (each, 2 patients [1.1%]).

Table V. Discontinuations in this study of 2 oral formulations of a dietary supplement containing a combination of calcium plus vitamin D_3 in Belgian adults (no. [%]) at risk for calcium and vitamin D deficiencies.*

Population/Reason for Withdrawal	Treatment Sequence AB	Treatment Sequence BA	All Patients
Randomized to treatment	104 (100.0)	96 (100.0)	200 (100.0)
Informed consent withdrawn; no trial medication taken	0 (0)	1 (1.0)	1 (0.5)
Intent-to-treat population	104 (100.0)	95 (100.0)	199 (100.0)
Adverse event(s)			
A	8 (7.7)	4 (4.2)	12 (6.0)
B	4 (3.8)	2 (2.1)	6 (3.0)
Other			
A	1 (1.0)	3 (3.2)	4 (2.0)
B	3 (2.9)	2 (2.1)	5 (2.5)

A = chewable tablet; B = effervescent powder.
*No significant between-formulation differences were found.

DISCUSSION

The results of the present study support a general preference for the chewable-tablet formulation over the effervescent powder. Acceptability of and preference for pharmacotherapy have been shown to be closely related to compliance,[2–4,14] which is in turn related to efficacy, especially in the long term. Thus, patients may be more compliant with the chewable-tablet formulation of the calcium-plus-vitamin D supplement and thus experience better long-term efficacy, reducing the risk for fracture, compared with the powder.

Several studies have shown that better compliance was reflected in better efficacy. Dawson-Hughes et al[1] showed the importance of long-term compliance with calcium and vitamin D supplementation, in that the beneficial effect on BMD (an indicator of fracture risk) in the total body or at any bone site in elderly (age, >65 years) patients did not persist when supplementation was discontinued. Consistent with this observation, serum osteocalcin concentrations (an indicator of bone turnover) returned to near-baseline levels within 2 years after patients discontinued supplementation.

Furthermore, it has been shown that calcium and vitamin D deficiencies are age related. Chapuy et al[15] found that dietary supplements of calcium and vitamin D slowed the rate of bone loss and, in turn, reduced fracture risk. Placebo-controlled trials have shown that calcium and vitamin D supplementation given for 18[16] and 36[17] months significantly reduced the risk for hip and other nonvertebral fractures in elderly patients.

The success of any treatment strategy in maintaining therapeutic benefit depends on compliance, which is closely related to tolerability and acceptability of the product.[2–4,14] Marriott[7] and Rees and Howe[8] found that the acceptability of taste is related to product preference and willingness to continue treatment on a long-term basis. For optimal compliance, the taste, size, and administration formulation of oral preparations should be acceptable and convenient. Based on the results of the previously mentioned studies, acceptability and preference of any dietary supplement containing calcium plus vitamin D_3 may influence compliance in the long term. An expected resulting improvement of BMD will prevent demineralization, bone loss, and fracture in the long term. However, the long-term effects of acceptability of 2 formulations of calcium and vitamin D supplements were beyond the scope of this study. Whether similar results can be found in long-term treatment periods should be the subject of future studies.

Based on the differences in formulation and active constituents of the 2 supplements studied, patients' preferences depended on the acceptability and tolerability of the product. The gastrointestinal events experienced by the patients in the present study are known to occur during treatment with calcium salts.

CONCLUSIONS

In this study of preference for and acceptability of 2 oral formulations (chewable tablet and effervescent powder) of a dietary supplement containing cal-

cium plus vitamin D_3 in Belgian adults at risk for calcium and vitamin D deficiencies, the chewable tablet was preferred by a significant majority. Based on 5 variables, the tablet was found to be significantly more acceptable than the powder. Tolerability was similar between the 2 formulations.

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